

## HALF LIFE ANSWERS

2004

3(a)	$14 - 6 = 8$	<sup>2</sup> 8		
3(b)	The time taken for half a radioactive sample to decay into something else.	<sup>1</sup> The time taken for half a radioactive sample to decay into something else/ The time for the activity of a radioactive sample to halve.		
3(c)(i)	$16 \times 20 = 320$ cpm	<sup>2</sup> 320 cpm (units not required)		
3(c)(ii)	$17\ 100 = 3$ half-lives activity = $\frac{1}{8} \times 320$ = 40 counts/min	<sup>2</sup> 3 half-lives calculated.	<sup>2</sup> 40 counts/min (units not required)	
	Unit of counts/min or counts min <sup>-1</sup> or cpm or counts per minute or min <sup>-1</sup> or Bq.	<sup>1</sup> Correct unit.		
3(d)	5.0g.....20 cpm = 4.0 cpm per gram = $\frac{1}{4} \times 16$ cpm per gram this indicates 2 half-lives this indicates 11 400 years  OR $5.0 \times 16 = 80$ cpm for 5.0 g living wood $20/80 = \frac{1}{4}$ of original = 2 half-lives = 2 x 5700 wood died 11 400 years ago.	<sup>2</sup> <b>4.0 cpm</b> per gram or <b>80 cpm</b> for 5 g (unit not required).  Or  <sup>2</sup> Incorrect counts per minute used to correctly calculate a half-life.	<sup>2</sup> <b>4.0 cpm</b> per gram or <b>80 cpm</b> for 5 g (unit not required) <b>and</b> Correct number of half-lives.	<sup>2</sup> Correct answer of 11 400 years ago. (unit not required).

2005

7(a)	Exponential graph drawn on axes. Graph starts at y-axis and never reaches x-axis.  Axes labelled <i>Activity / Counts per second / Number of radioactive atoms</i> against <i>time / Half life</i> (units not required).  Point at half maximum activity drawn across to graph line with line dropped onto time axis and labelled half-life (but can only accept if Graph starts at y-axis) . <b>OR</b> A value on y-axis chosen and interpolated, half the value chosen interpolated – difference in time is half-life.	Exponential graph drawn. (Graph starts at / close to y-axis and never reaches x-axis.)	Achievement <i>plus</i> both axes suitably labelled.	Merit <i>plus</i> construction lines shown enabling half-to be correctly calculated.
------	--	--	--	--

7(b)	The half-life of a radioactive material is the time taken for the activity of the sample to decrease to half of its original value (or other correct definition).	The time taken for half a radioactive sample to decay into something else / The time for the activity of a radioactive sample to halve.		
9	<p>10 g of a living sample has an activity of 234.5 cpm.</p> <p>To drop to a count of 25 cpm, the activity has halved a little more than three times.</p> <p><math>3 \times \text{half-life} = 3 \times 5\,730 = 17\,190</math></p> <p>Hence approximate age = 18 000 years.</p>	<p>Conversion of one of the two activities, so dealing with equivalent mass:</p> <p>250 cpm per 100 gram of tree trunk</p> <p><b>OR</b></p> <p>23.45 cpm for 10 g of living tree</p> <p><b>OR</b></p> <p>other conversion such as both to cpm per g (unit not required).</p>	Correct number of half-lives. (actual = 3.22, accept 3 – 4.)	Correct answer of Approximately 18000 years (actual = 18451 years – accept range from 17190 – 22920) (unit not required).

2006

4(a)	The lead stops beta particles/radioactivity escaping. Allow to stop gamma only if candidate explains gamma may be by product of beta decay	Correct answer.		
4(b)	The time taken for half the (number of) radioactive nuclei to decay <b>or</b> the time for the rate of decay of an isotope to halve. <b>or</b> the time for the activity of to halve	Correct answer.		
4(c)	M = 2.0 g. When the cobalt decays, it changes into another type of nucleus which also has mass, it doesn't disappear. The decrease in mass is negligible.		Correct answer of 2.0 g or statement that the mass does not change (significantly).	Correct answer of 2.0 g or statement that the mass does not change (significantly). <b>And</b> idea that when the cobalt decays, it changes into another type of nucleus which also has mass.
4(d)	<p><math>\frac{1}{4}</math> is two half-lives, ie 10.4 years ie 2011.</p> <p>Accept 2012 as well.</p>	Correct answer of 2011 or 2012.		

2007

(h)	<p>By calculation:</p> <p>One half-life is 8 days (since the rate falls to <math>\frac{1}{4}</math> after 16 days).</p> <p>28 days is 3.5 half-lives.</p>	Correct number of half-lives calculated to be 8 days	Half-life calculated to be 8 days <b>and</b> 28 days is 3.5 half-lives	Half-life calculated to be 8 days <b>and</b> 28 days is 3.5 half – lives <b>and</b> use of 3 half-lives = 75 and 4
-----	---	--	--	--

	<p>Rate = <math>600 \times \left(\frac{1}{2}\right)^{3.5}</math></p> <p>Rate = 53</p> <p>By graphing:</p> <p>After 1 half-life, count rate = <math>\frac{600}{2} = 300</math></p> <p>After 2 half-lives, count rate = <math>\frac{300}{2} = 150</math></p> <p>After 3 half-lives, count rate = <math>\frac{150}{2} = 75</math></p> <p>After 4 half-lives, count rate = <math>\frac{75}{2} = 37.5</math></p> <p>From graph, decay rate after 28 days is about 50 counts per second.</p>	<p><b>OR</b></p> <p>Points plotted on graph:</p> <p>8 days = 300</p> <p>16 days = 150</p> <p>24 days = 75</p> <p>32 days = 37.5</p> <p>If BOTH methods used, award highest grade from either method.</p>	<p><b>OR</b></p> <p>Points plotted on graph:</p> <p>8 days = 300</p> <p>16 days = 150</p> <p>24 days = 75</p> <p>32 days = 37.5</p> <p><b>AND</b></p> <p><b>Accurate</b> exponential curve drawn (do not accept joining the dots with a ruled line).</p>	<p>half-lives = 37.5 / calculation of <math>1 / 2^{3.5}</math> to arrive at answer of 53</p> <p><b>OR</b></p> <p>Points plotted on graph:</p> <p>8 days = 300</p> <p>16 days = 150</p> <p>24 days = 75</p> <p>32 days = 37.5</p> <p><b>AND</b></p> <p><b>Accurate</b> exponential curve drawn (do not accept joining the dots with a ruled line).</p> <p><b>AND</b></p> <p>Answer <b>matches graph</b> (construction lines preferred but not required).</p>
--	--	--	--	---